AIR INTAKE AND METHOD FOR BREATHING AIR USING AN AIR INTAKE

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates to an air intake and a method for breathing air using the air intake which are preferably employed in aerospace industry.

Description of the related art

[0002] An air intake is an important constituent element to affect on the engine performance of a supersonic air-breathing engine or the like because the air intake deaccelerates and compresses the air inflow introduced therein. The air intake can be classified as an internal compression type air intake, an external compression type air intake or a mixed compression type air intake. Particularly, the mixed compression type air intake is balanced because the air intake can exhibit intermediate features, in comparison with the internal compression type air intake and the external compression type air intake.

[0003] Fig. 1 is a cross sectional view schematically illustrating the structure of a conventional mixed compression type air intake, and Fig. 2 is an enlarged perspective view illustrating the forefront of the air intake illustrated in Fig. 1. As is apparent from Figs. 1 and 2, the air intake 10 includes a center structural body 11 called as a "spike" and a cowl 12 provided so as to enclose the rear portion of the spike 11 via a space 13. The spike 11 is formed axial symmetrically, and has a porous wall 14 at the side thereof.

[0004] If the air intake 10 is installed in a supersonic air breathing engine, it can generate a shock wave from an air inflow introduced therein through the impact with the forefront 11A of the spike 11. In this case, the air inflow is partially leaked as a spillage flow outside from the space 13 formed by the spike 11 and the cowl 12, so that the capture flow ratio of the air inflow may be decreased. Since the shock wave tends to be receded from the cowl rip 12A as the velocity of the air inflow is decreased, the capture flow ratio of the air inflow is also decreased when the velocity of the air inflow is decreased below the designed velocity range of air inflow of the air intake 10.

[0005] Moreover, the shock wave is introduced directly into the space 13 as

the velocity of the air inflow is increased, generating a flow field with a strong inversive pressure gradient in the air intake 10. In this case, a boundary layer, which is composed of a flow flux with a relatively low flow velocity and formed nearby the inner walls of the spike 11 and the cowl 12, may be destroyed, and the air flow may be shut off from the air intake 10. As a result, it may be that the air intake 10 can not be started. In this point of view, with the air intake 10 illustrated in Figs. 1 and 2, since the porous wall 14 is partially provided at the side of the spike 11, the boundary layer is released into an air bleeding path 15 via the porous wall 14, and then, released outside from the air intake 10 through the air bleeding path 15. In this case, however, since the air inflow is partially released outside from the air intake 10, in consequence, the capture flow ratio of the air inflow is decreased.

SUMMERY OF THE INVENTION

[0006] It is an object of the present invention, in this point of view, to inhibit the reduction in capture flow ratio of the air inflow introduced into the air intake.

[0007] In order to achieve the above-mentioned objects, this invention relates to an air intake including:

a spike including a plurality of plates which are arranged axial symmetrically around a central axis thereof, and

a cylindrical cowl having an inner wall parallel to the central axis and provided so as to enclose a rear portion of the spike via a given space,

wherein adjacent ones of the plates form respective aerodynamic compressive surfaces in spaces formed by the adjacent ones, and the distances between the adjacent ones of the plates are variable, and the distance between a forefront of the spike along the central axis and the cowl is variable.

[0008] In the air intake of the present invention, the spike composing the air intake is made of a plurality of plates which are arranged axial symmetrically around the central axis of the air intake so that the main surfaces of the plates are perpendicular to the central axis of the air intake. The distances between the adjacent plates are variable, and the distance between the forefront of the spike along the central axis and the cowl is variable. Moreover, the adjacent plates form respective aerodynamic compressive surfaces.

[0009] Therefore, when an air inflow is introduced into the air intake, if the

distances between the adjacent plates and/or the distance between the forefront of the spike and the cowl are controlled, an shock wave, which is generated at the forefront of the spike, is introduced into the forefront of the cowl rip along the aerodynamic compressive surfaces. As a result, regardless of the velocity of the air inflow, the air inflow can be introduced into the space formed by the spike and the cowl through the shock wave, and the capture flow ratio of the air inflow can be increased.

[0010] According to the present invention, the shock wave can not be introduced directly into the cowl if the distance control is performed as mentioned above, without the structural complication of the air intake such as the formation of a porous wall and/or an air bleeding path. In addition, since the spike is made of plates, the total weight of the air intake can be decreased.

[0011] Other features and advantages of the present invention will be described in detail hereinafter. Also, a method for breathing air using the air intake of the present invention will be described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

For better understanding of the present invention, reference is made to the attached drawings, wherein

Fig. 1 is a cross sectional view schematically illustrating the structure of a conventional mixed compression type air intake,

Fig. 2 is an enlarged perspective view illustrating the forefront of the air intake illustrated in Fig. 1,

Fig. 3 is an enlarged perspective view illustrating the forefront of an air intake according to the present invention,

Fig. 4 is an explanatory view relating to the operation of the air intake illustrated in Fig. 3,

Fig. 5 is another explanatory view relating to the operation of the air intake illustrated in Fig. 3,

Fig. 6 is an explanatory view relating to the flow condition between the adjacent plates composing the spike of the air intake illustrated in Fig. 3, and

Fig. 7 is an enlarged side view illustrating the forefront of another air intake modified from the one illustrated in Fig. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] This invention will be described in detail with reference to the accompanying drawings.

Fig. 3 is an enlarged perspective view illustrating the forefront of an air intake according to the present invention.

Figs. 4 and 5 are explanatory views relating to the operation of the air intake illustrated in Fig. 3.

[0013] An air intake 20 illustrated in Fig. 3 includes a spike 25 composing of a plurality of circular plates 22 which are arranged axial symmetrically around a central axis 21 so that the main surfaces of the circular plates 22 are perpendicular to the central axis 21. The spike 25 also includes a steeple 23 and a base 24 to fix the central axis thereto. A cowl 26 is provided so as to enclose the base 24 of the spike 25 via a space 27.

[0014] The surface areas of the circular plates 22 are successively increased toward the base 24 from the steeple 23, and the adjacent ones of the circular plates 22 form aerodynamic compressive surfaces in spaces 28. The distances between the adjacent plates 22 are variable and the distance between the forefront of the steeple 23 and the cowl 26 is variable.

[0015] Herein, the phrase "the formation of the aerodynamic compressive surfaces" means the condition that in the spaces 28, shear-layers are formed between respective circular flows and respective main flows of the air inflow introduced into the air intake 10 as illustrated in Fig. 6. The shear-layers functions as solid walls for the air inflow to guide the air inflow to the cowl rip as described below.

[0016] When the air inflow is introduced into the air intake 20 on the condition that the velocity of the air inflow is larger than the designed velocity of air inflow of the air intake 20, as illustrated in Fig. 4, the distances between the adjacent circular plates 22, that is, the widths L of the spaces 28 formed by the adjacent circular plates 22 are increased, and the distance between the forefront of the steeple 23 and the cowl 26 is increased to slenderize the spike 25. In this case, the air inflow is impacted with the steeple 23 or the edges of the circular plates 22 to form a shock wave to be introduced into the cowl rip 26A. Therefore, the spillage of the air inflow can be weakened and the capture flow

ratio of the air inflow can be increased.

[0017] If the distances between the adjacent circular plates 22 and the distance between the forefront of the steeple 23 and the cowl 26 are controlled appropriately, the shock wave can not be introduced directly into the space 27, that is, the cowl 26. In this case, therefore, the air intake 20 can be started under good condition. In the present invention, it is not required to provide an additional porous wall at the side of the spike 25 and an additional air bleeding path at the spike 25, so that the total structure of the air intake 20 can be simplified.

[0018] On the other hand, when the air inflow is introduced into the air intake 20 on the condition that the velocity of the air inflow is smaller than the designed velocity of air inflow of the air intake 20, as illustrated in Fig. 5, the distances between the adjacent circular plates 22, that is, the widths L of the spaces 28 formed by the adjacent circular plates 22 are decreased, and the distance between the forefront of the steeple 23 and the cowl 26 is decreased to shorten the spike 25. In this case, the air inflow is impacted with the steeple 23 or the edges of the circular plates 22 to form a shock wave to be introduced into the cowl rip 26A. Therefore, the spillage of the air inflow can be weakened and the capture flow ratio of the air inflow can be increased.

[0019] As mentioned above, in the air intake 20 according to the present invention, regardless of the velocity of the air inflow to be introduced into the air intake 20, the capture flow ratio of the air inflow can be increased only if the distances between the adjacent circular plates 22 and the distance between the forefront of the steeple 23 and the cowl 26 are controlled appropriately.

[0020] It is desired that the relation of $L/D \leq 1$ is satisfied if the depth of each space 28 formed by the adjacent circular plates 22 is defined as "D" and the width of each space 28 along the central axis 21 is defined as "L". In the air intake 20, since the spike 25 is composed of circular plates 22, if the air inflow is impacted to the edges of the circular plates 22 to generate a shock wave, the (total) pressure loss of the air inflow may occur due to the shock wave. If the above relation of $L/D \leq 1$ is satisfied, however, the shock wave can be weakened even though the air inflow is impacted to the edges of the circular plates 22, so that the pressure loss of the air inflow due to the shock wave can be reduced.

[0021] Preferably, the L/D is set to about 0.5. In this case, the shock wave can be almost perfectly weakened at the edges of the circular plates 22, and thus, the pressure loss of the air inflow due to the shock wave can be almost perfectly reduced.

[0022] Fig. 7 is an enlarged side view illustrating the forefront of another air intake modified from the one illustrated in Fig. 3. In an air intake 25 illustrated in Fig. 7, the adjacent circular plates 22 are separated by respective spacers 29. In this case, the spaces 28 between the adjacent circular plates 22 are defined by the thicknesses of the spacers 29, and if the thicknesses of the spacers 29 are controlled appropriately, the degree of freedom of the L/D can be increased.

[0023] Although the present invention was described in detail with reference to the above examples, this invention is not limited to the above disclosure and every kind of variation and modification may be made without departing from the scope of the present invention.

[0024] In Fig. 3, for example, although the circular plates 22 are provided outside from the cowl 26, some of the circular plates 22 may be provided so as to be enclosed by the cowl 26. In this case, however, it may be that the shock wave can not be introduced into the cowl rip 26A, and thus, the capture flow ratio of the air inflow is decreased. Moreover, although the spike 25 is composed of the circular plates 22, the spike 25 may be composed of another shaped plates only if the requirements according to the present invention are satisfied.

[0025] As mentioned above, according to the present invention can be provided an air intake and an air breathing method using the air intake, whereby the capture flow ratio of an air inflow to be introduced into the air intake can be increased.